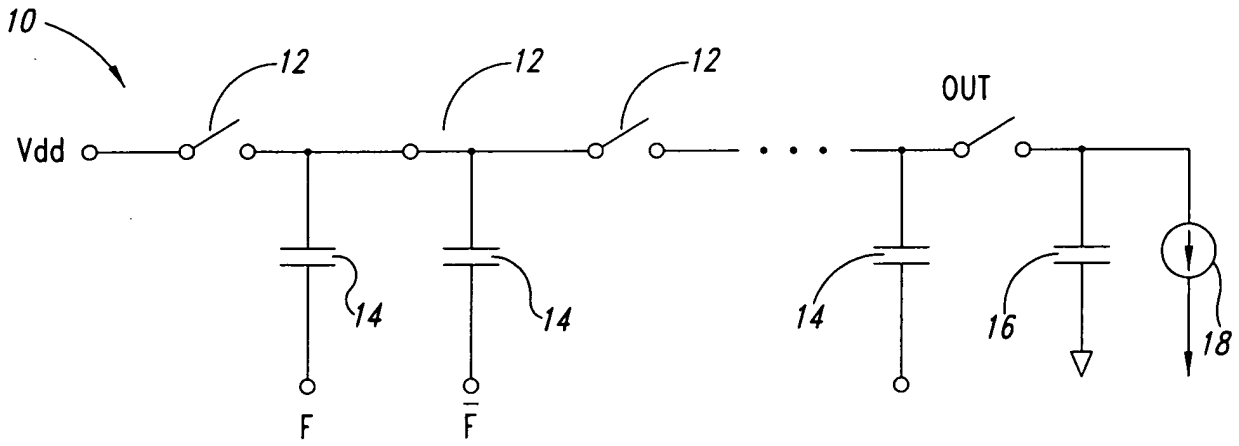
10
12
12
12
OUT
Vdd
14
14
14
16
18
F
F

Fig. 1

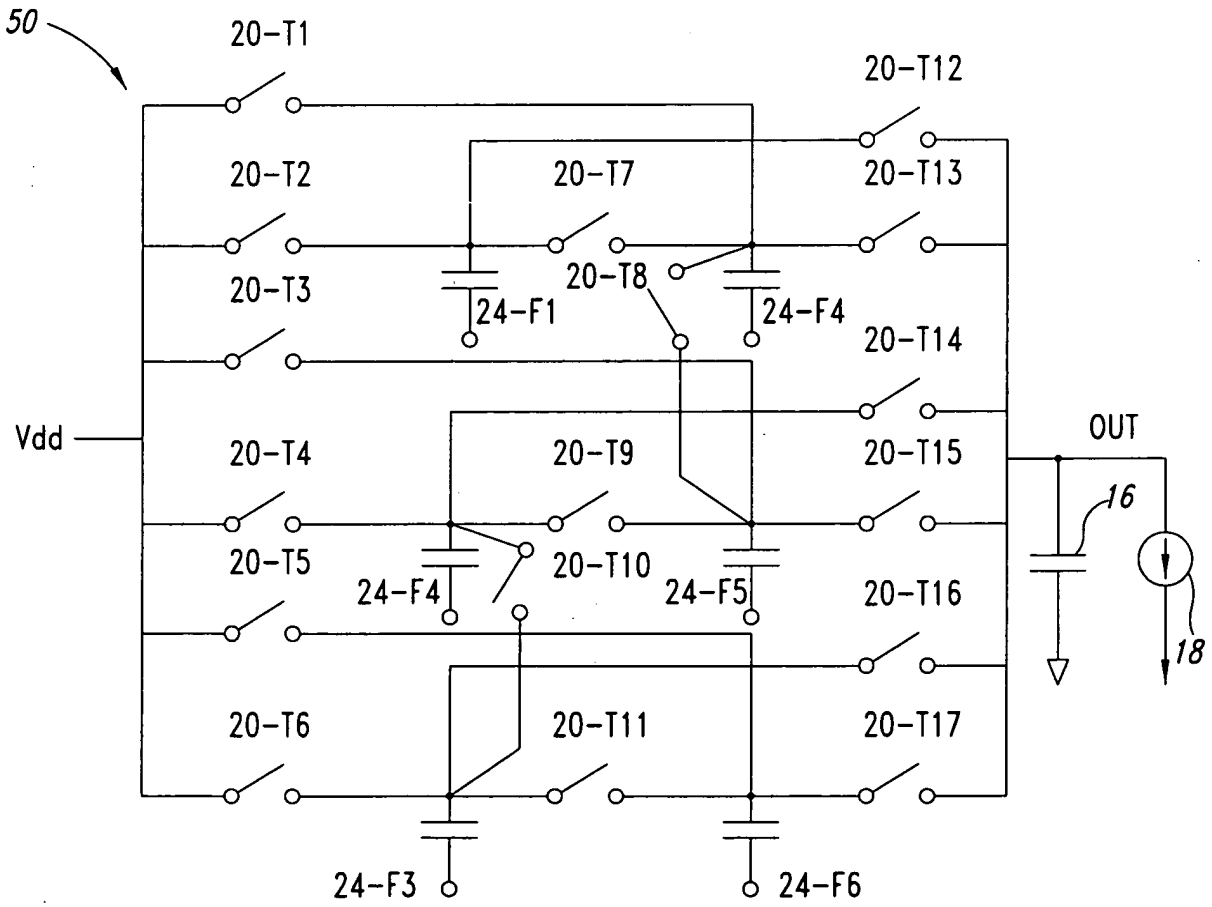
50
20-T1
20-T12
20-T2
20-T7
20-T13
20-T3
20-T8
24-F1
24-F4
20-T14
Vdd
20-T4
20-T9
20-T15
OUT
16
20-T5
24-F4
20-T10
24-F5
20-T16
18
20-T6
20-T11
20-T17
24-F3
24-F6

Fig. 2

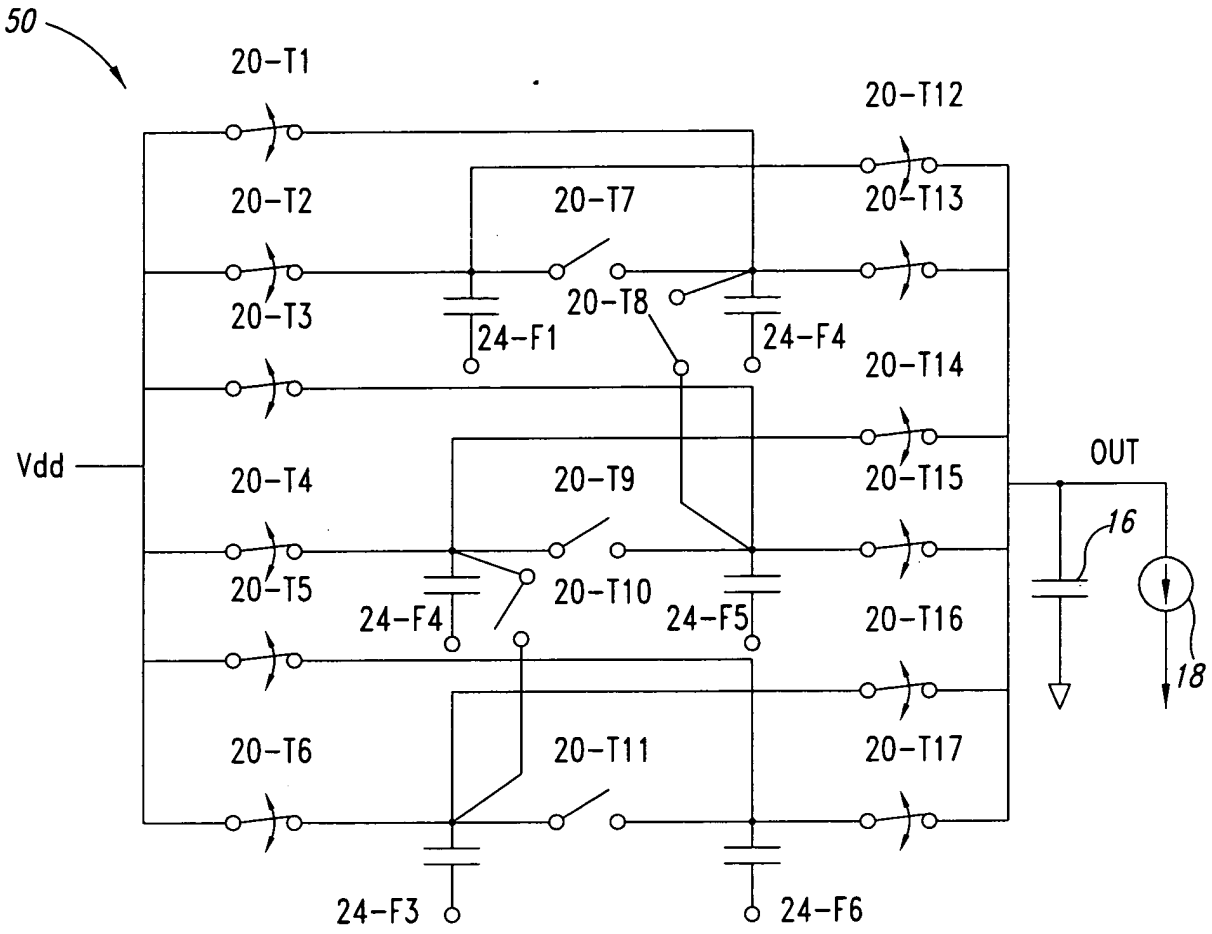

Fig. 3A

N	F_1	F_2	F_3	F_4	F_5	F_6
1	F	F	F	F	F	F

N	F_{T1}	F_{T2}	F_{T3}	F_{T4}	F_{T5}	F_{T6}	F_{T12}	F_{T13}	F_{T14}	F_{T15}	F_{T16}	F_{T17}
1	$\overline{F}$	$\overline{F}$	$\overline{F}$	$\overline{F}$	$\overline{F}$	$\overline{F}$	F	F	F	F	F	F

Fig. 3B

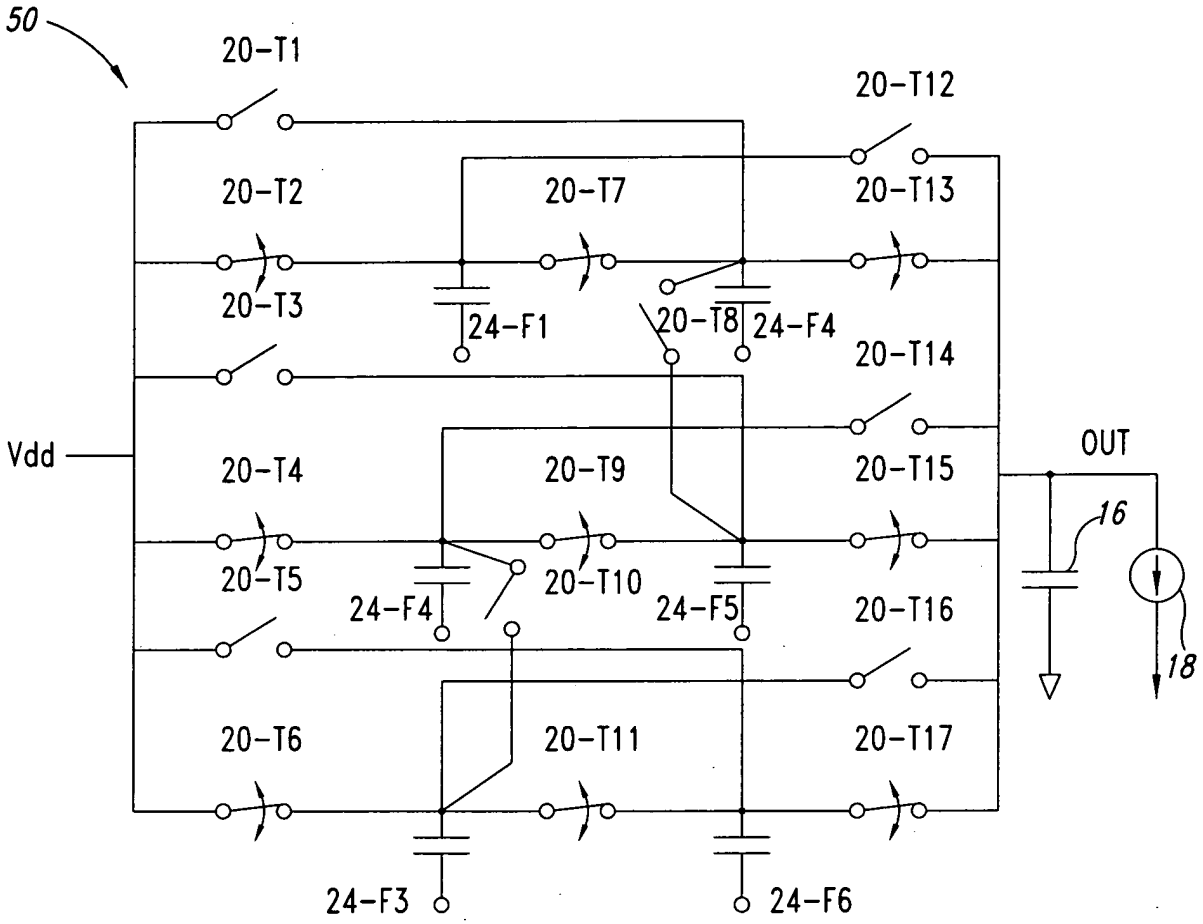

Fig. 4A

N	F_1	F_2	F_3	F_4	F_5	F_6
2	F	F	F	$\overline{F}$	$\overline{F}$	$\overline{F}$

N	F_{T2}	F_{T4}	F_{T6}	F_{T7}	F_{T9}	F_{T11}	F_{T13}	F_{T15}	F_{T17}
2	$\overline{F}$	$\overline{F}$	$\overline{F}$	F	F	F	$\overline{F}$	$\overline{F}$	$\overline{F}$

Fig. 4B

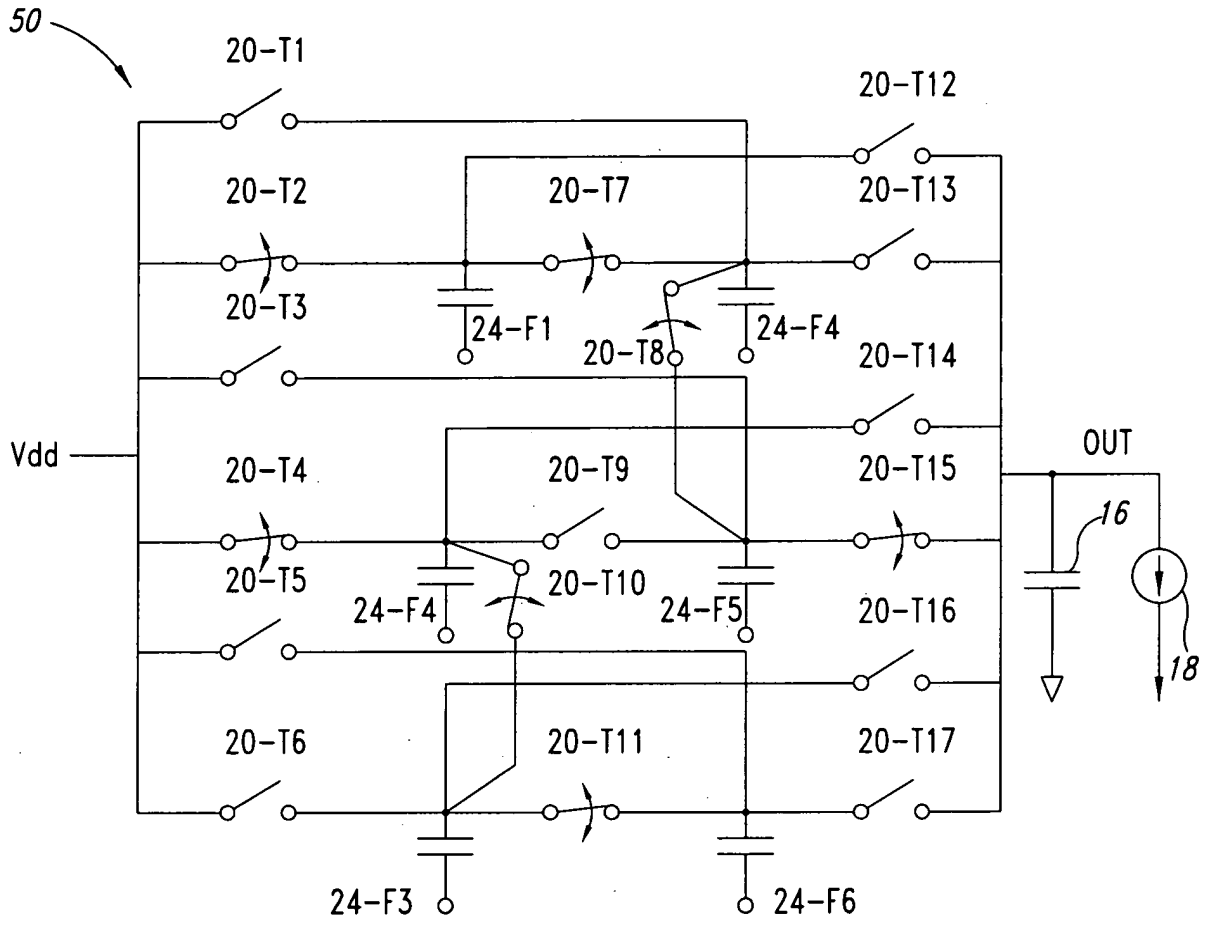

Fig. 5A

N	F_1	F_2	F_3	F_4	F_5	F_6
3	F	F	$\overline{F}$	$\overline{F}$	F	F

N	F_{T2}	F_{T4}	F_{T7}	F_{T8}	F_{T10}	F_{T11}	F_{T15}	F_{T17}
3	$\overline{F}$	$\overline{F}$	F	$\overline{F}$	F	$\overline{F}$	F	F

Fig. 5B

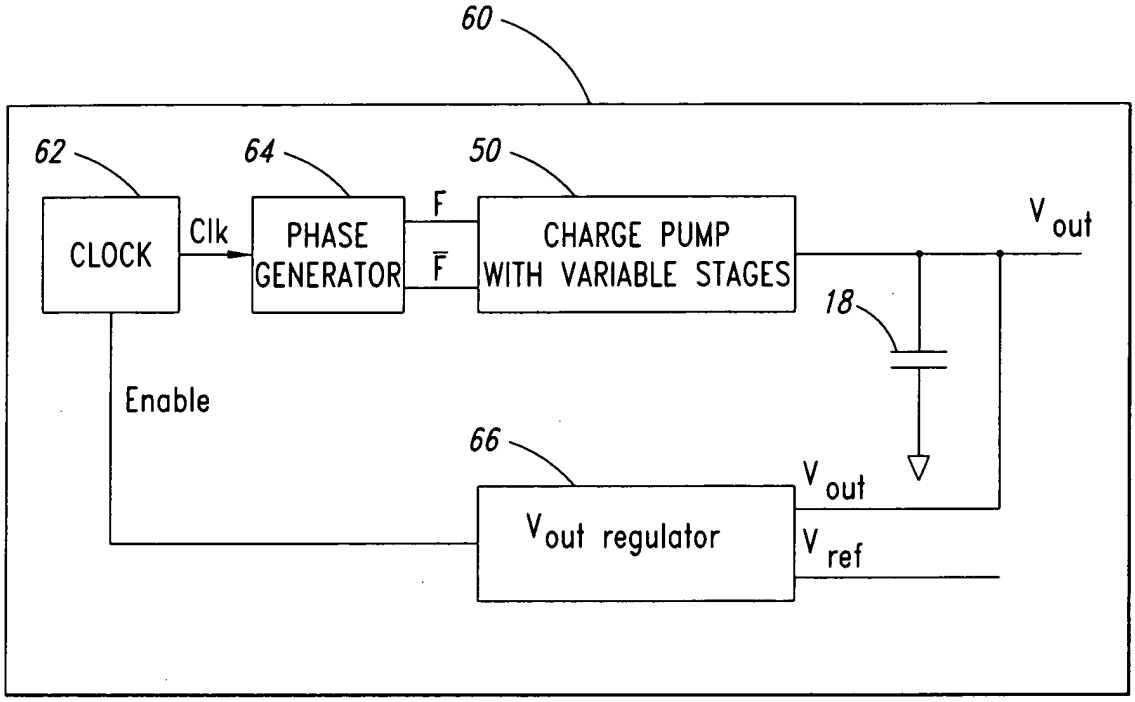
60
62
64
50
CLOCK
Clk
PHASE GENERATOR
F
$\bar{F}$
CHARGE PUMP WITH VARIABLE STAGES
V_{out}
18
Enable
66
V_{out}
V_{out} regulator
V_{ref}

Fig. 6

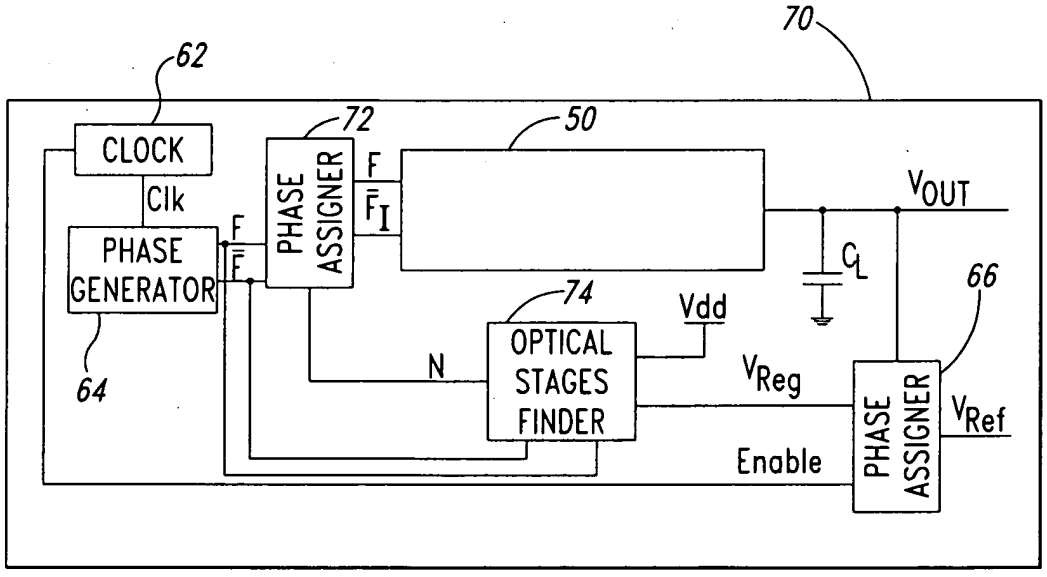
70
62
CLOCK
Clk
PHASE GENERATOR
64
F
$\bar{F}$
72
PHASE ASSIGNER
F_I
$\bar{F}_I$
50
V_{OUT}
C_L
66
74
Vdd
N
OPTICAL STAGES FINDER
V_{Reg}
PHASE ASSIGNER
V_{Ref}
Enable

Fig. 7

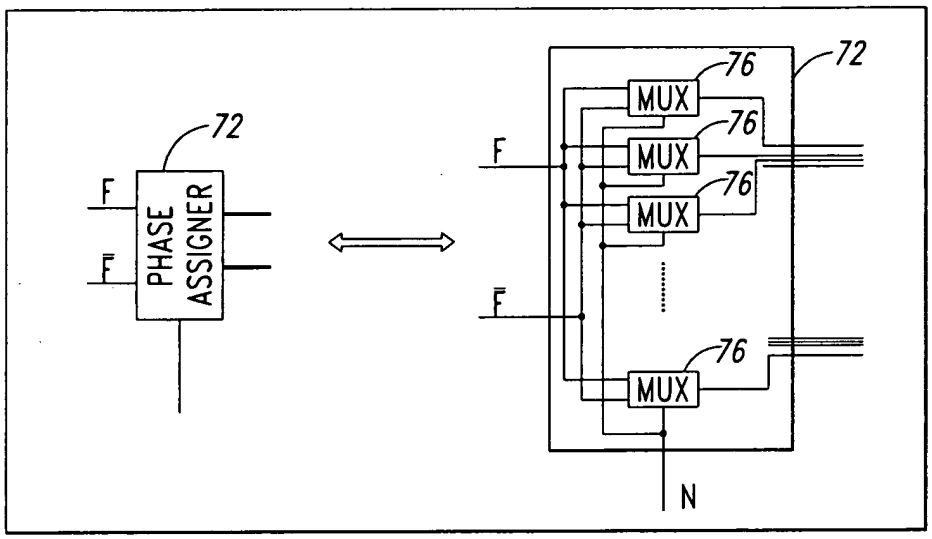
72
F
F
PHASE ASSIGNER
MUX
MUX
MUX
MUX
76
76
76
76
72
F
F
N

Fig. 8

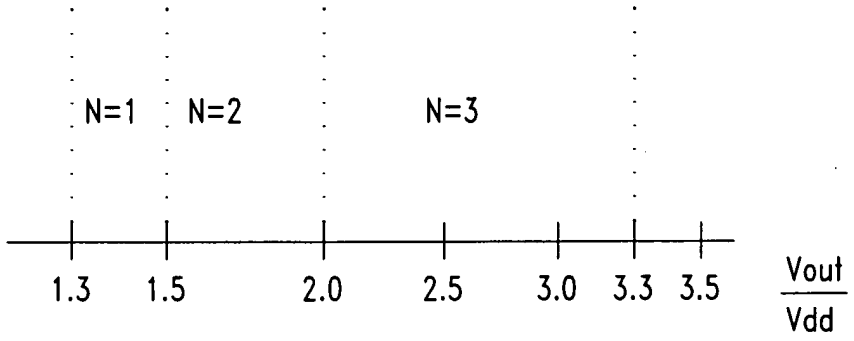
N=1
N=2
N=3
1.3
1.5
2.0
2.5
3.0
3.3
3.5
Vout
Vdd

Fig. 9

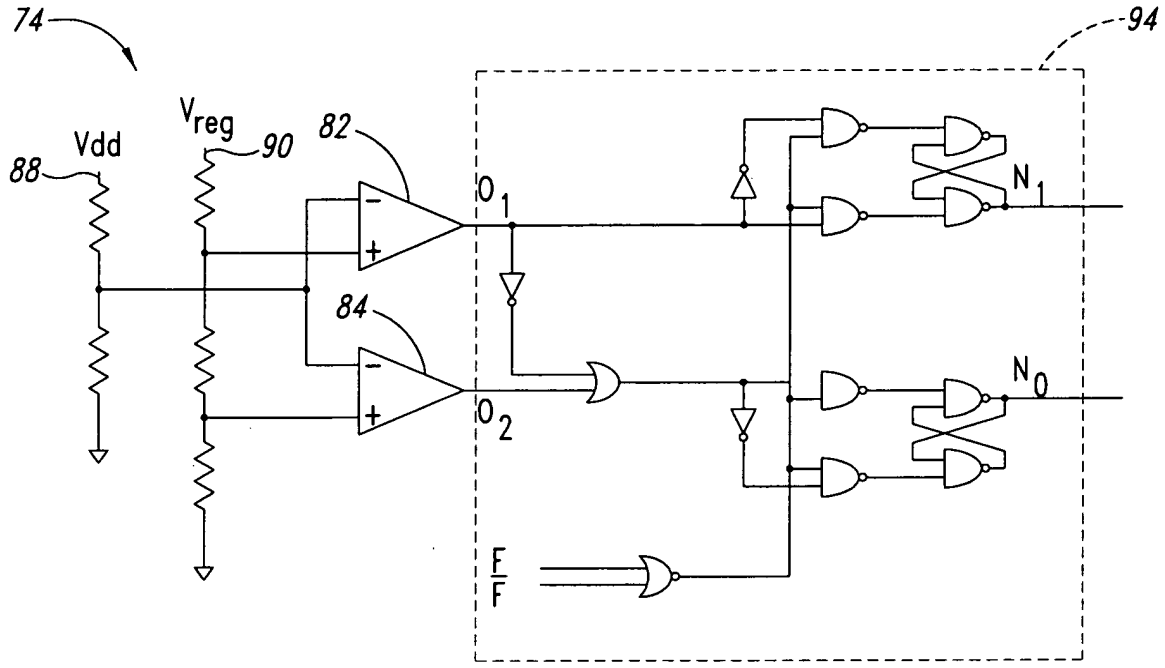

Fig. 10A

$\left(\frac{V_{out}}{V_{dd}}\right)_{min}$	$\left(\frac{V_{out}}{V_{dd}}\right)_{max}$	O_1	O_2	N_1	N_0
1.3	1.5	0	0	0	1
1.5	2.0	1	0	1	0
2.0	3.3	1	1	1	1

Fig. 10B

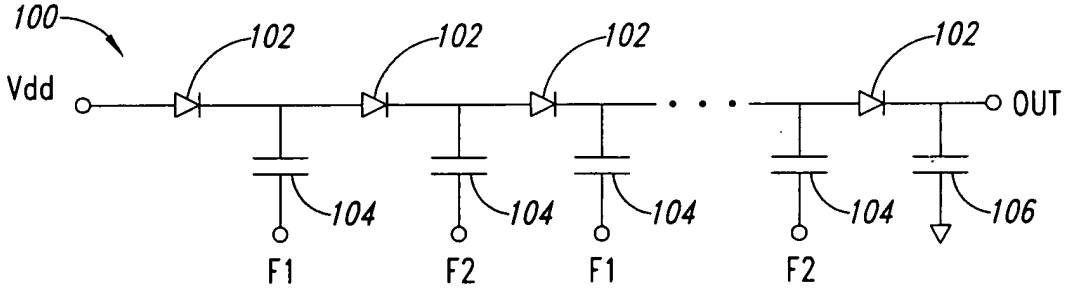

Fig. 11

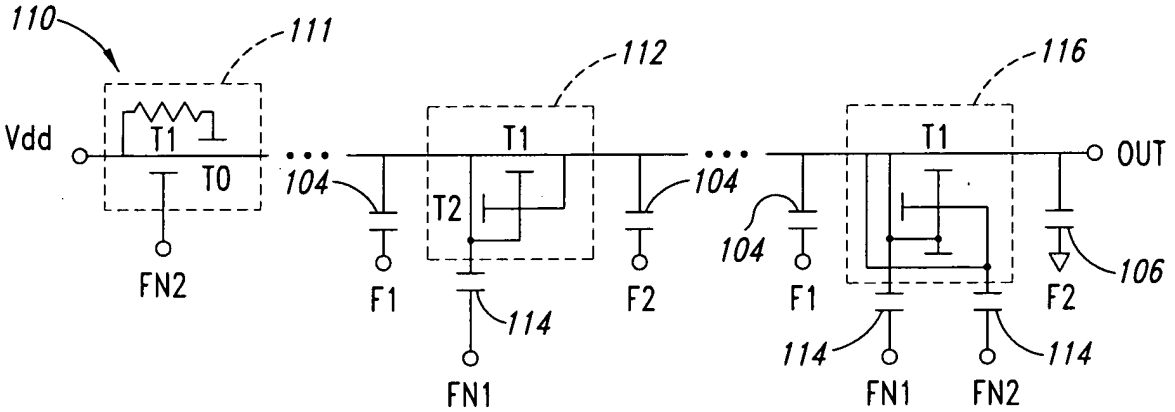

Fig. 12

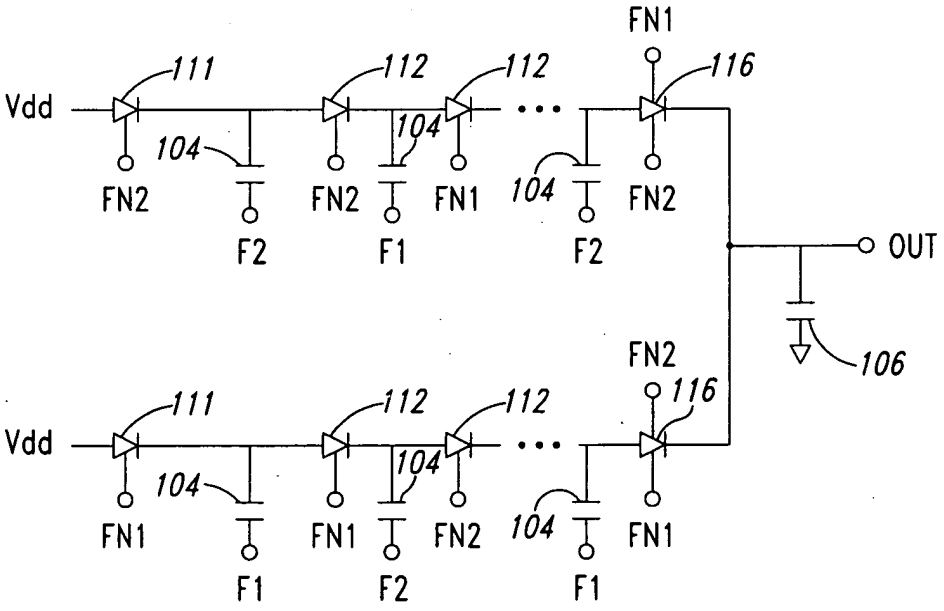

Fig. 13

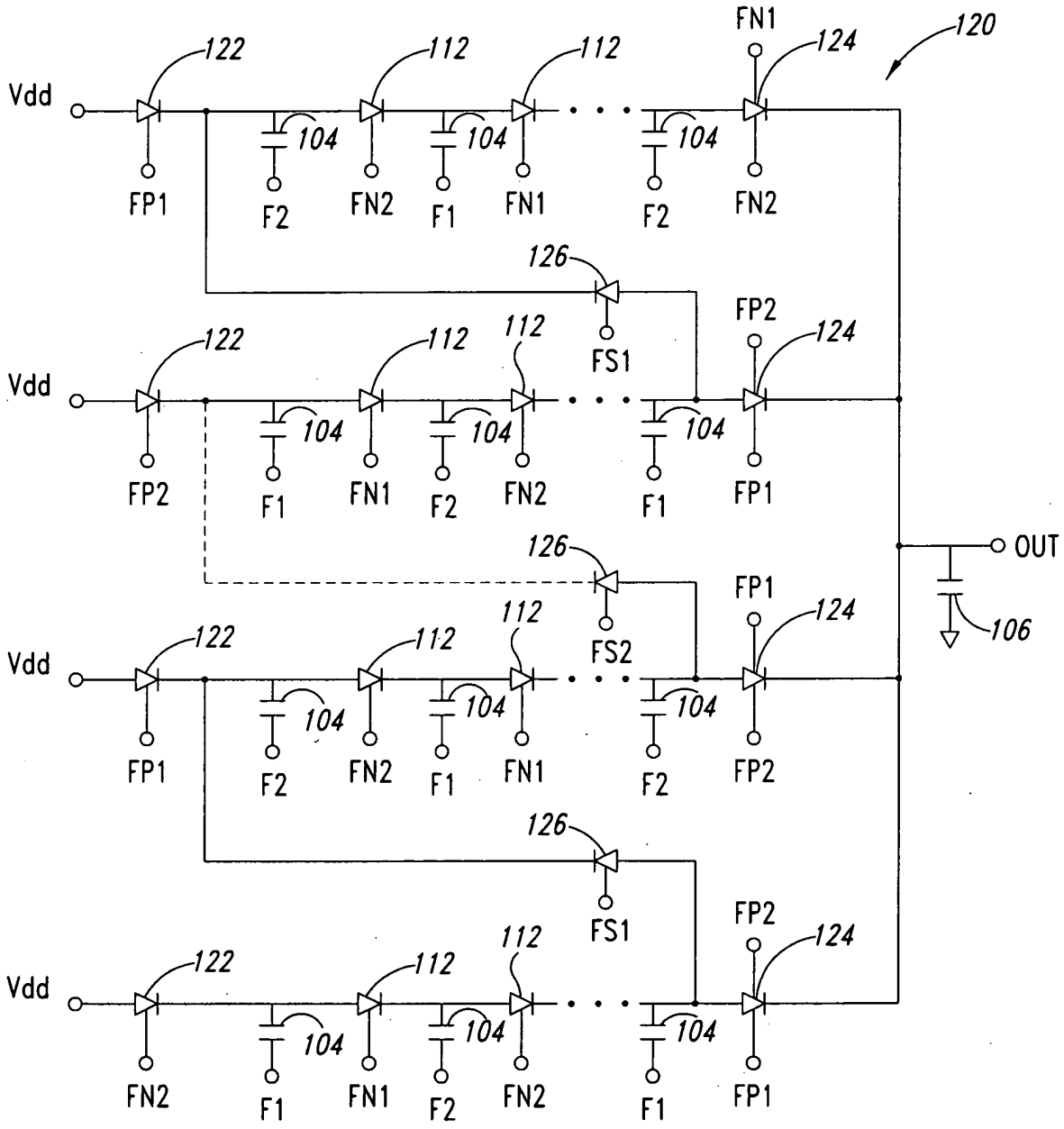

Fig. 14

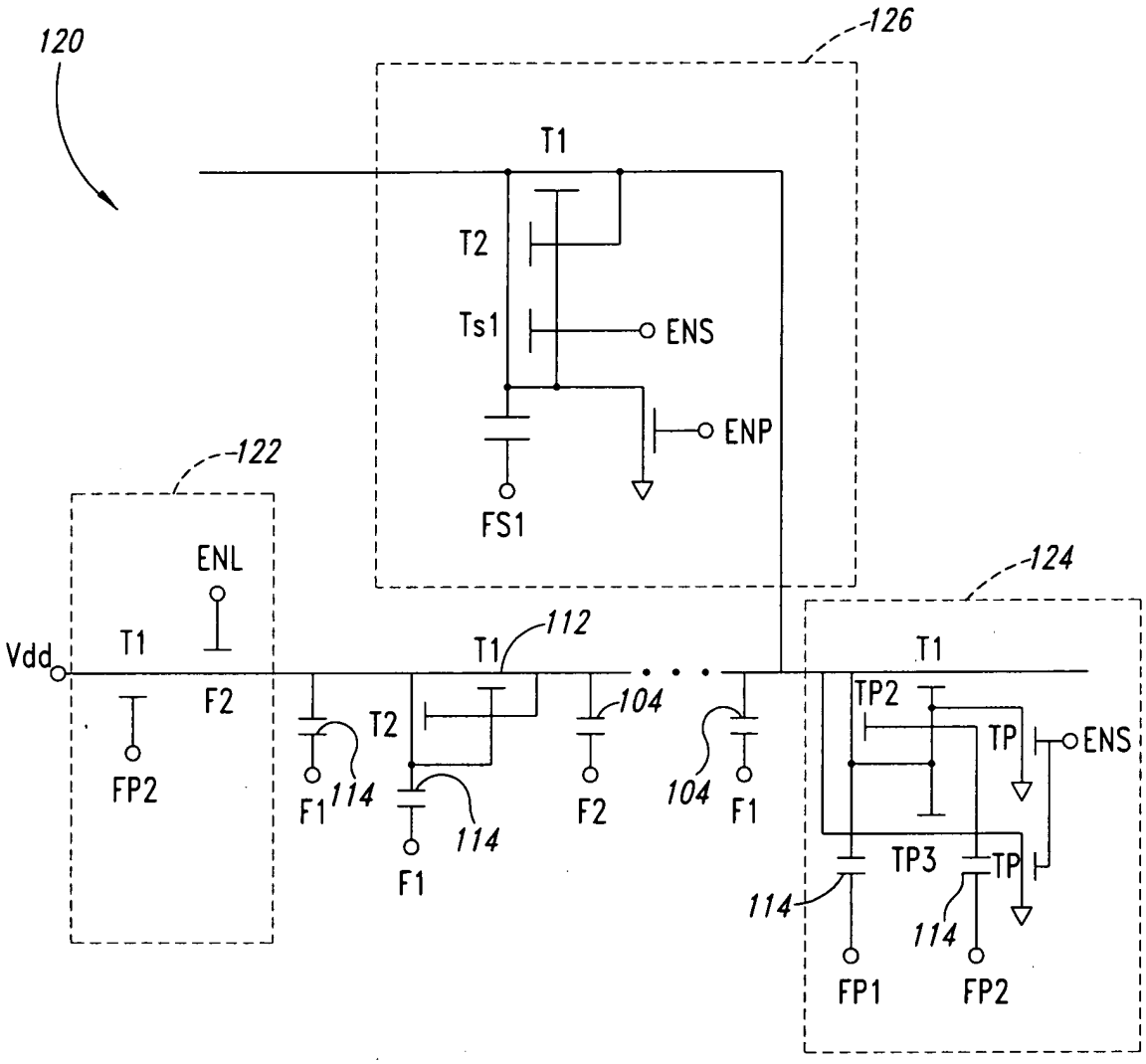
120
126
T1
T2
Ts1
ENS
ENP
FS1
122
ENL
T1
F2
FP2
Vdd
T1
112
T2
F1
114
F1
114
104
F2
104
F1
124
T1
TP2
TP
ENS
TP3
TP
114
114
FP1
FP2

Fig. 15

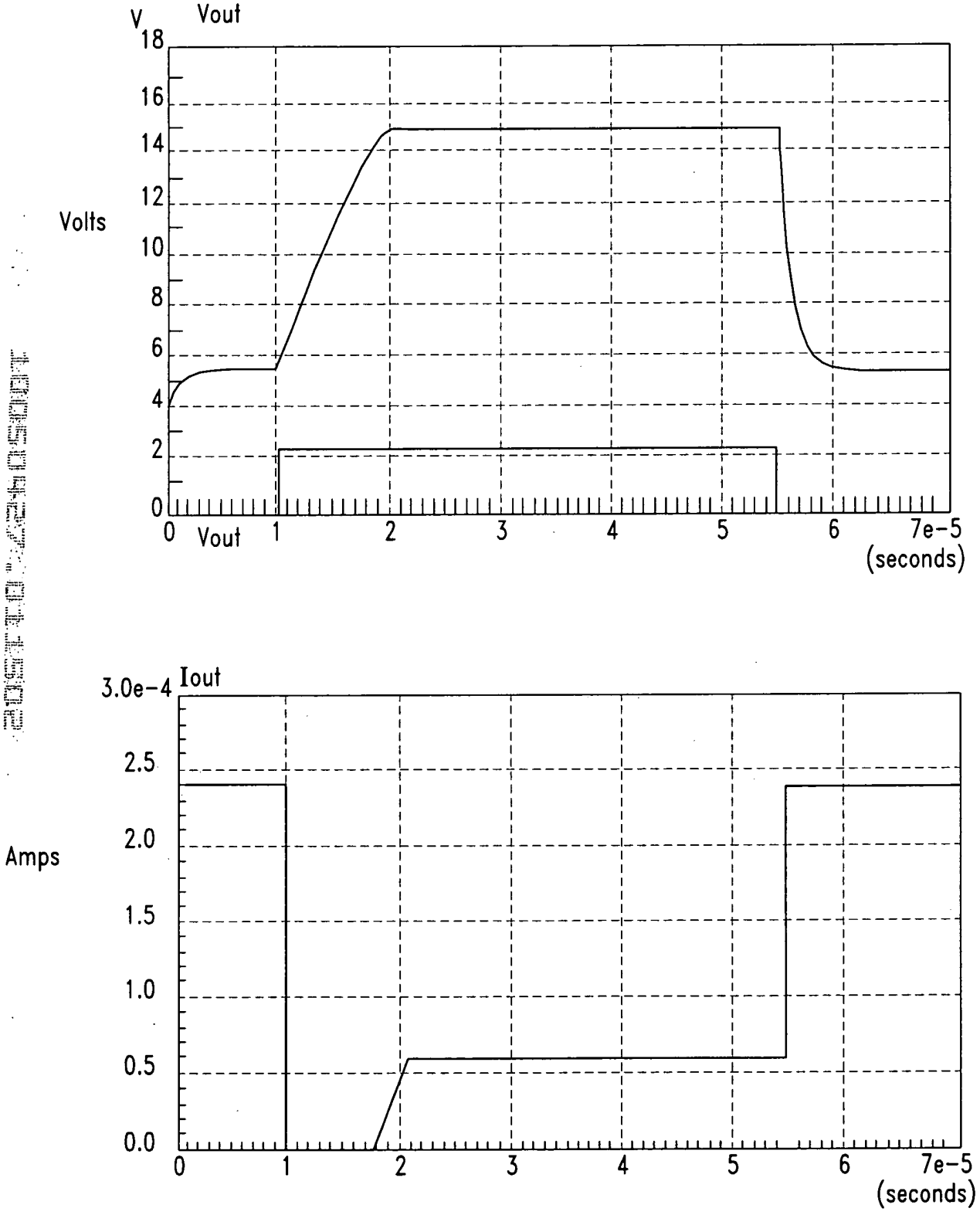
V
Vout
18
16
14
12
10
8
6
4
2
0
Volts
0
Vout
1
2
3
4
5
6
7e-5
(seconds)
3.0e-4
Iout
2.5
2.0
1.5
1.0
0.5
0.0
Amps
0
1
2
3
4
5
6
7e-5
(seconds)

Fig. 16